

## PATENT SPECIFICATION

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(54) PROCESS FOR CATALYTICALLY REACTING GASES  
 HAVING A HIGH SULPHUR DIOXIDE CONTENT IN A  
 CONTACT PLANT

(71) We, METALLGESELLSCHAFT AKTIENGESELLSCHAFT, a body corporate organised under the Laws of Germany, of 6 Frankfurt am Main, Reuterweg 14, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for catalytically reacting gases having a high sulphur dioxide content in a contact plant which comprises a plurality of series-connected contact trays.

During the catalytic reaction of sulphur dioxide-containing gases with air to form sulphur trioxide which is subsequently used to produce sulphuric acid, the catalyst must be heated by the gas to the so-called initiation temperature. This initiation temperature depends upon the composition of the catalyst and on the process by which it has been made and, e.g., with catalysts based on vanadium pentoxide ( $V_2O_5$ ) it is 400—450°C. The reaction of sulphur dioxide to form sulphur trioxide results in a temperature rise because the reaction is exothermic. With gases which contain up to about 11% by volume of sulphur dioxide, the reaction is arrested at a temperature of about 620°C., where the equilibrium of the reaction  $SO_2 + 1/2 O_2 \rightleftharpoons SO_3$  is reached. With gases having a higher sulphur dioxide content, the temperature continues to rise because the reaction reaches its equilibrium only at higher temperatures, and the catalyst will deteriorate at a temperature above about 620°C.

It has been proposed to avoid overheating the catalyst in order to prevent deterioration thereof by mixing sulphur trioxide-containing gases with the sulphur dioxide-containing gases before these are admitted into the first contact tray. The admixed sulphur trioxide retards the conversion of the sulphur dioxide to sulphur trioxide so that overheating will be avoided if the mixing and the residence

time of the gases in the contact trays are properly controlled. Because in the course of time the catalyst loses activity, particularly in the first contact tray, the rate of the reaction  $SO_2 + 1/2 O_2 \rightleftharpoons SO_3$  and the conversion of the gas to form sulphur trioxide are reduced accordingly. Whereas in the treatment of gases containing less than about 11% by volume of sulphur dioxide by this proposed method, more catalyst may be used than is theoretically required in order to compensate for loss in catalyst activity, this is not possible in the case of gases having a high sulphur dioxide content because the reaction must be interrupted before the temperature which is critical for the catalyst is reached, i.e. considerably before the equilibrium is reached.

According to the present invention there is provided a process for catalytically reacting gases having a high content of sulphur dioxide in a contact plant which comprises a plurality of series-connected contact trays containing catalyst, wherein a partial stream of partly reacted gases which contain sulphur trioxide, is mixed with the sulphur dioxide-containing gases before they are admitted into the first contact tray, and the gases are subjected to interstage cooling between contact trays, and wherein at least part of said partial stream of partly reacted gases is conducted through an absorber for absorbing sulphur trioxide from the gases before being mixed with the sulphur dioxide-containing gases, and the rate at which sulphur trioxide is absorbed in the absorber is increased in dependence upon the increase in loss of activity of the catalyst in such a manner that the rate of conversion of sulphur dioxide into sulphur trioxide in the contact trays remains substantially constant.

Preferably the entire partial stream which is branched off is conducted through the absorber. In that case, an automatic control of the branching off and mixing is not necessary.

In order to enable the invention to be more

[Price 33p]

readily understood, reference will be made to the accompanying drawing, which illustrates diagrammatically and by way of example a flow diagram of one embodiment of plant for carrying out the process of the present invention.

The plant shown in the drawing comprises a contact vessel which contains four contact trays 1a to 1d with interstage coolers 2a to 2c connected between the contact trays. A cooler 3 is provided for the gases leaving the contact vessel, while an absorber 4 for absorbing sulphur trioxide from a partial stream of gases is connected to a mixer 5. A stream A of gases having a high sulphur dioxide content is supplied to the mixer 5, and the resulting stream E of mixed gases is supplied into the contact vessel where it passes in succession through the contact trays 1a to 1d and the interstage coolers 2a to 2c. A stream B of the gases which have partly been reacted to form sulphur trioxide leaves the contact vessel and is cooled in the cooler 3. A partial stream C is branched from the stream B and supplied to the absorber 4, where sulphur trioxide is removed from said partial stream at a controlled rate. The resulting stream D which leaves the absorber 4 is supplied to the mixer 5 and is mixed therein with the stream A. A stream F of the partial stream C may by-pass the absorber 4 as indicated in dotted lines. The invention will now be further illustrated by the following example of the operation of the plant shown in the drawing.

The stream A was supplied a rate of 50,000 standard cubic meters per hour and with composition of

50% SO<sub>2</sub>  
30% O<sub>2</sub>  
balance N<sub>2</sub>

A partial stream C at a rate of 5000 standard cubic metres per hour was constantly branched off from the product from the contact plant and was entirely or in part conducted through the absorber 4. The plant was run for a period of years and during the first year, no sulphur trioxide was absorbed in the absorber 4. In that case, the stream E contained 3.37% SO<sub>2</sub> and stream B contained 22.14% SO<sub>2</sub> and 37.14% SO<sub>3</sub>.

In the second year, 30% of the sulphur trioxide was absorbed in the absorber 4. In that case, stream E contained 2.33% SO<sub>2</sub> and stream B contained 22.41% SO<sub>2</sub> and 36.34% SO<sub>3</sub>.

In the third year, 60% of the sulphur trioxide was absorbed in the absorber 4. In that case, the stream E contained 1.32% SO<sub>2</sub> and the stream B contained 22.68% SO<sub>2</sub> and 35.56% SO<sub>3</sub>.

In the fifth year, 100% or all of the sulphur trioxide was absorbed in the absorber 4. In that case, the stream E contained no SO<sub>2</sub> and the stream B contained 23.03% SO<sub>2</sub> and 34.54% SO<sub>3</sub>.

The total conversion in the plant remained virtually constant at 60%.

Stream B was subjected to further processing in conventional manner.

An advantage of the present process is that the conversion to sulphur trioxide is maintained virtually constant in spite of the loss of activity of the catalyst and also that the gas rates remain virtually constant so that an optimum and simple operation can be effected. Furthermore, fluctuations of the gas composition of stream A can be compensated to a considerable extent.

#### WHAT WE CLAIM IS:—

1. A process for catalytically reacting gases having a high content of sulphur dioxide in a contact plant which comprises a plurality of series-connected contact trays containing catalyst, wherein a partial stream of partly reacted gases which contain sulphur trioxide, is mixed with the sulphur dioxide-containing gases before they are admitted into the first contact tray, and the gases are subjected to interstage cooling between contact trays, and wherein at least part of said partial stream of partly reacted gases is conducted through an absorber for absorbing sulphur trioxide from the gases before being mixed with the sulphur dioxide-containing gases, and the rate at which sulphur trioxide is absorbed in the absorber is increased in dependence upon the increase in loss of activity of the catalyst in such a manner that the rate of conversion of sulphur dioxide into sulphur trioxide in the contact trays remains substantially constant.

2. A process for catalytically reacting gases having a high content of sulphur dioxide in a contact plant substantially as hereinbefore described with reference to the accompanying drawing.

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*

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